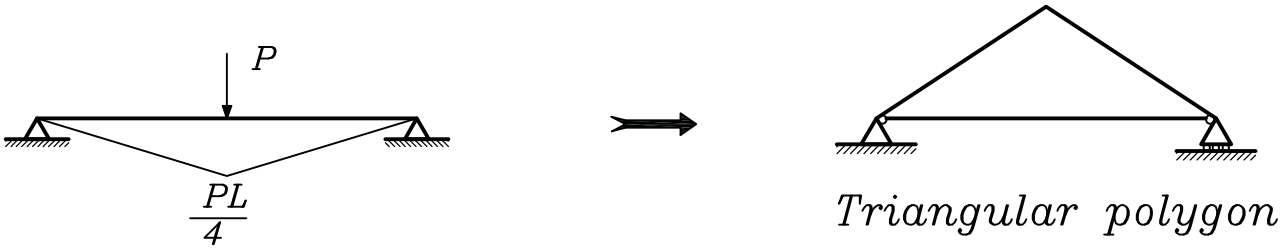
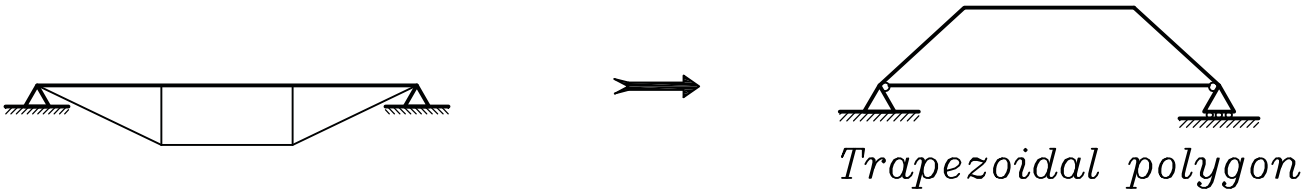
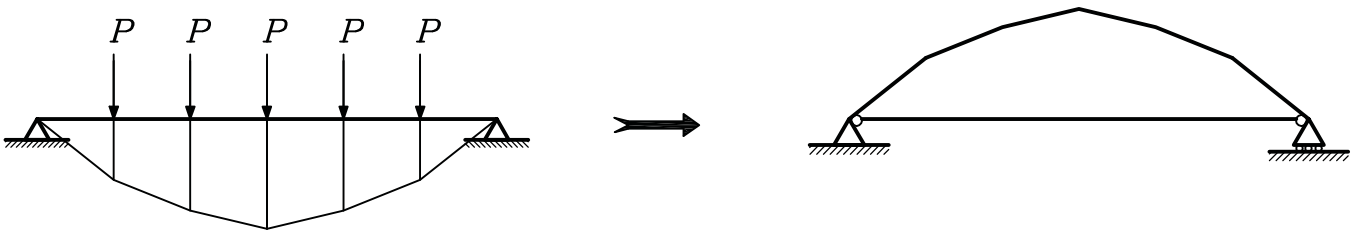
Arch girder

كما سبق وجدنا عندما يكون شكل المنشا مقلوب شكل *(B.M.D.)* فان *(BM=0)* وتصبح القوى الداخلية عبارة عن قوى محورية فقط.



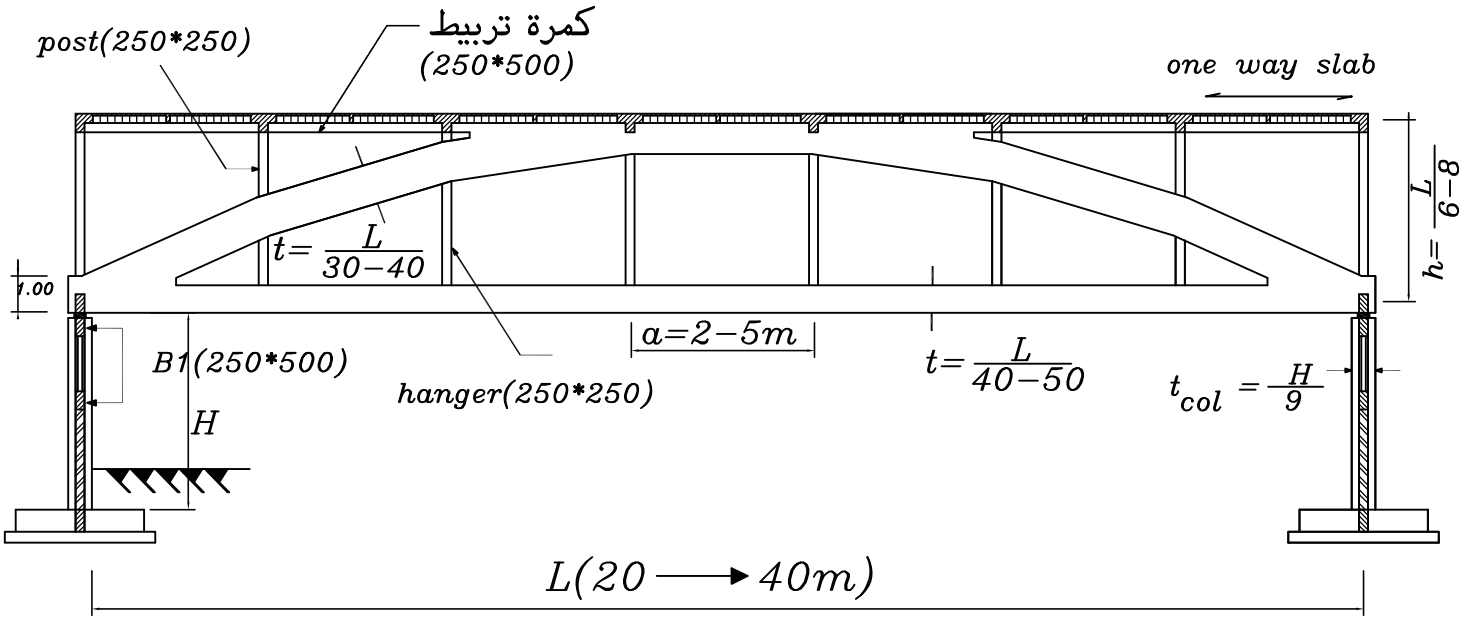


ولكن اذا زاد عدد *(concentrated loads)* فان عدد *(Joints)* او الكسرات يزداد ويسمى فى هذه الحالة *(Arch girder)*



وكما سبق فان البلاطات يجب ان تكون *(One way slabs)* فى اتجاه الكمرات الثانوية وبالتالى تكون الاحمال مركزة عند *(joints)* فقط.

By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir



-Arch girder is used for span L (20-40m)

Concrete Dimensions

$$t(\text{Arch girder}) = \frac{L}{30-40}$$

$$b = \begin{cases} 30cm \\ \frac{Spacing}{20} \end{cases}$$ ايهما أكبر

$$t_{(tie)} = \frac{L}{40-50}$$

$$h = \frac{L}{6-8}$$

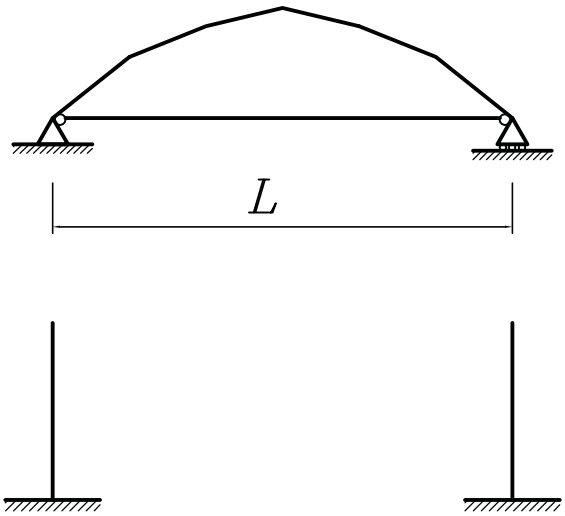
$$t_{(Colum)} = \frac{H}{9}$$

Hanger or post (250*250)

ملحوظة

اذا كانت المسافة بين (hangers or posts) اقل من او تساوى $\frac{spacing}{2}$ فان البلاطات تكون (One way solid slabs) اما اذا كانت اكبر من $\frac{spacing}{2}$ فان البلاطات تكون (One way H.B.slabs)

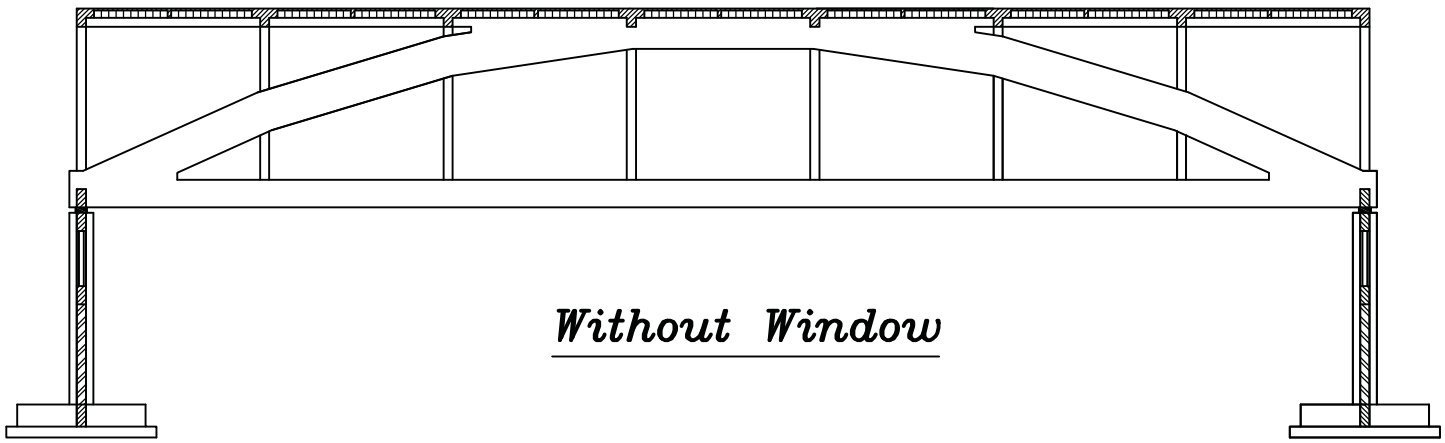
Statical system



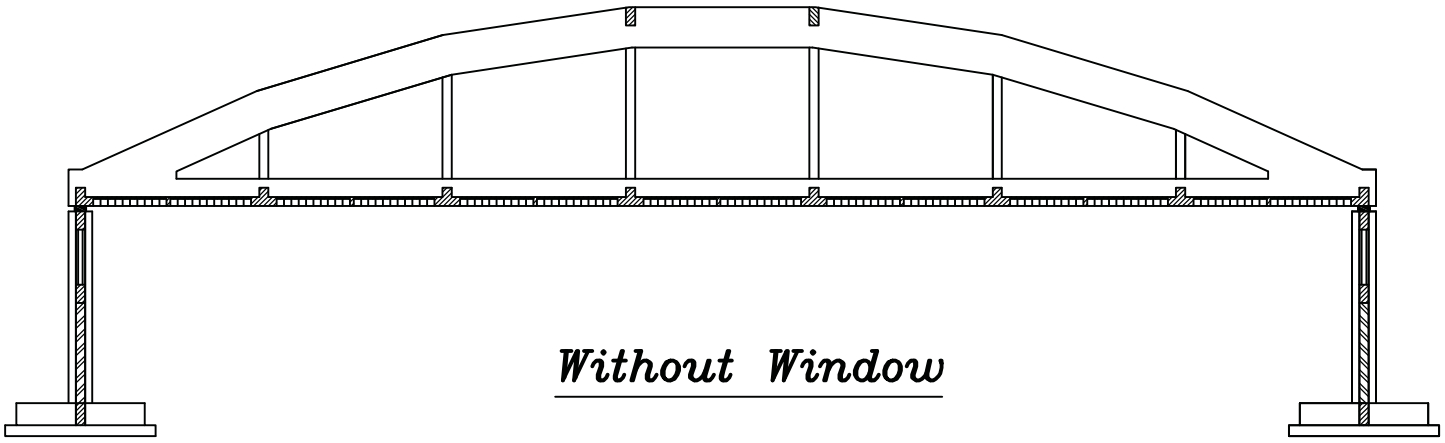
ملحوظة

لا توجد ترحيل للقواعد لان الاعمدة عليها *(N.f.)* فقط

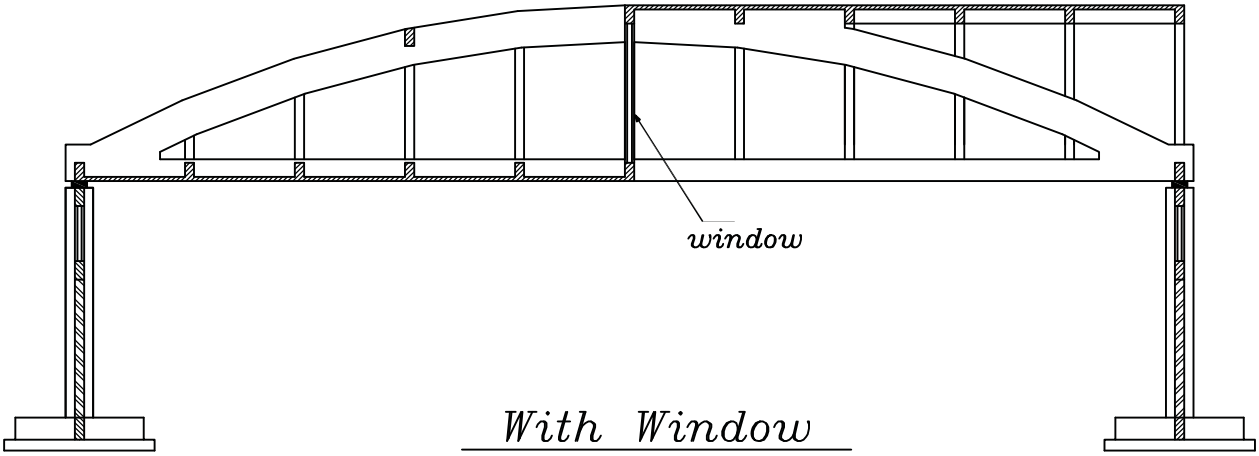
Positions of slabs



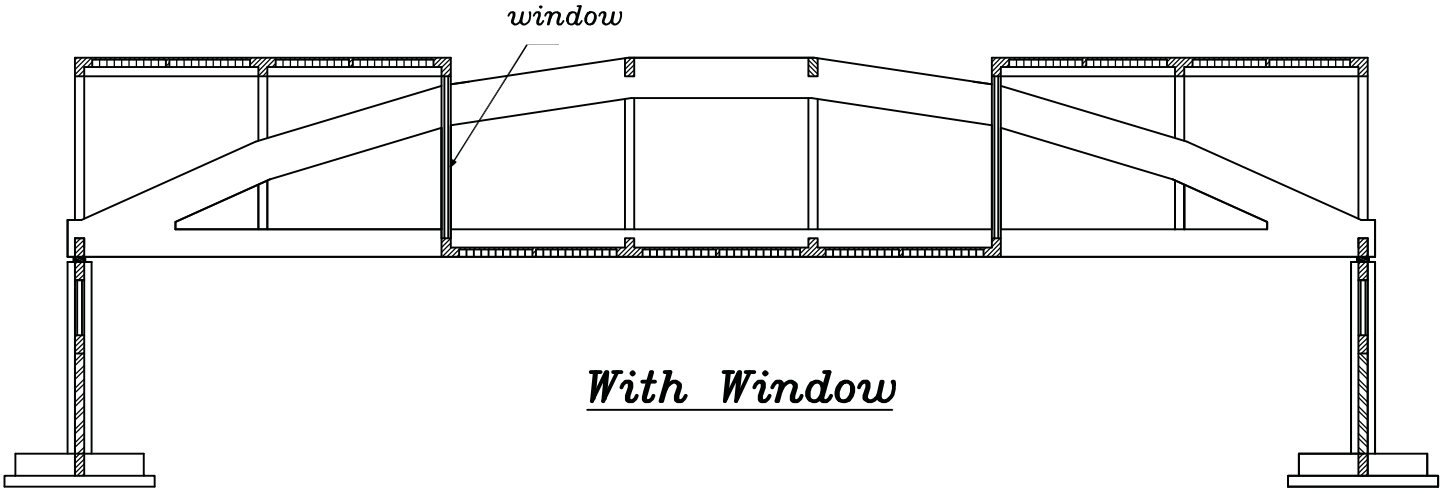
Without Window



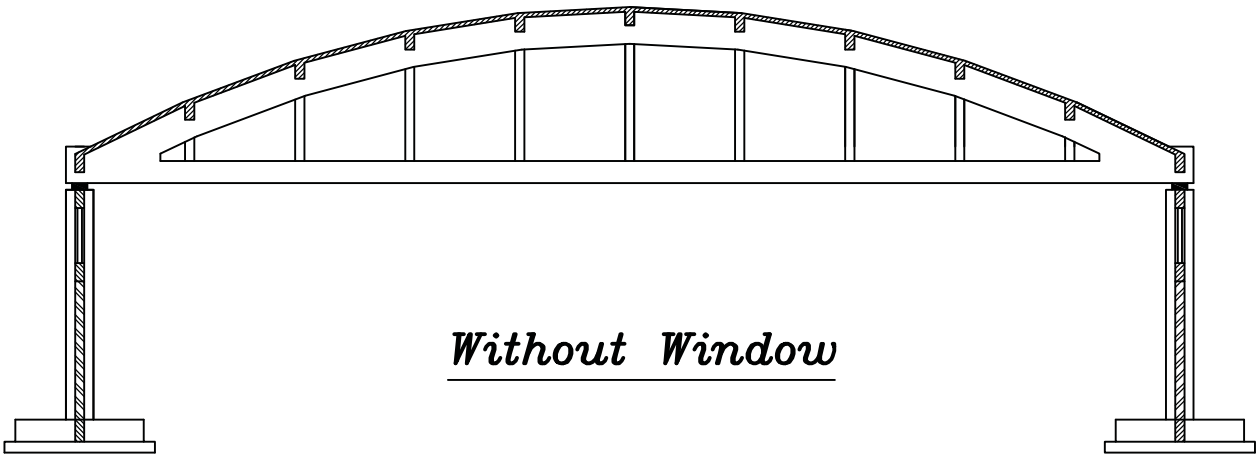
Without Window



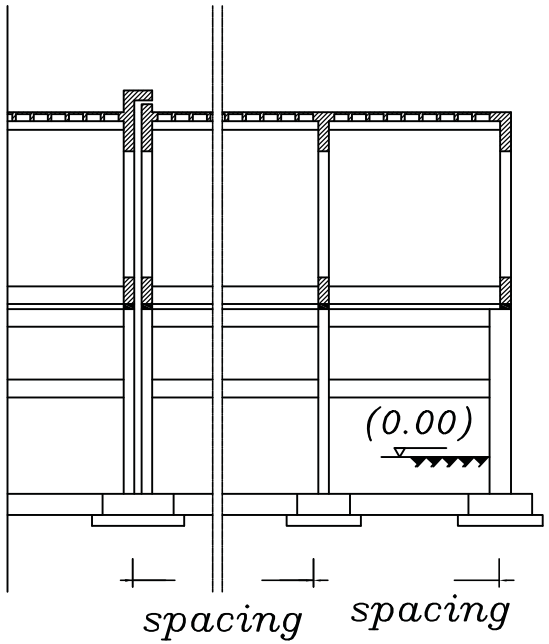
With Window



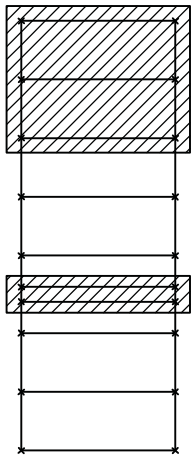
With Window



Without Window

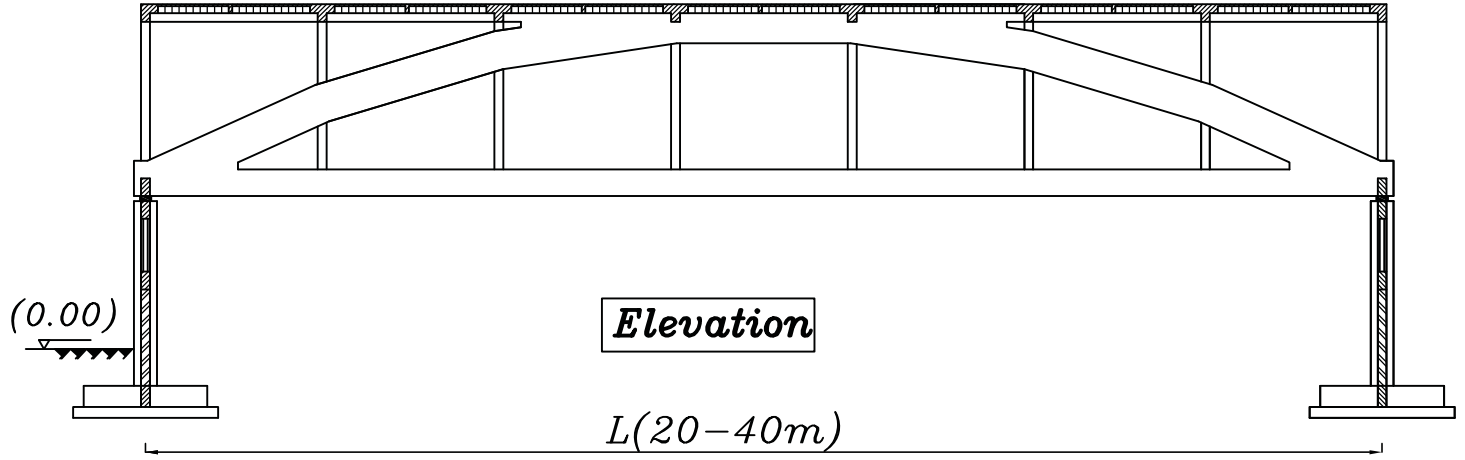


Side view

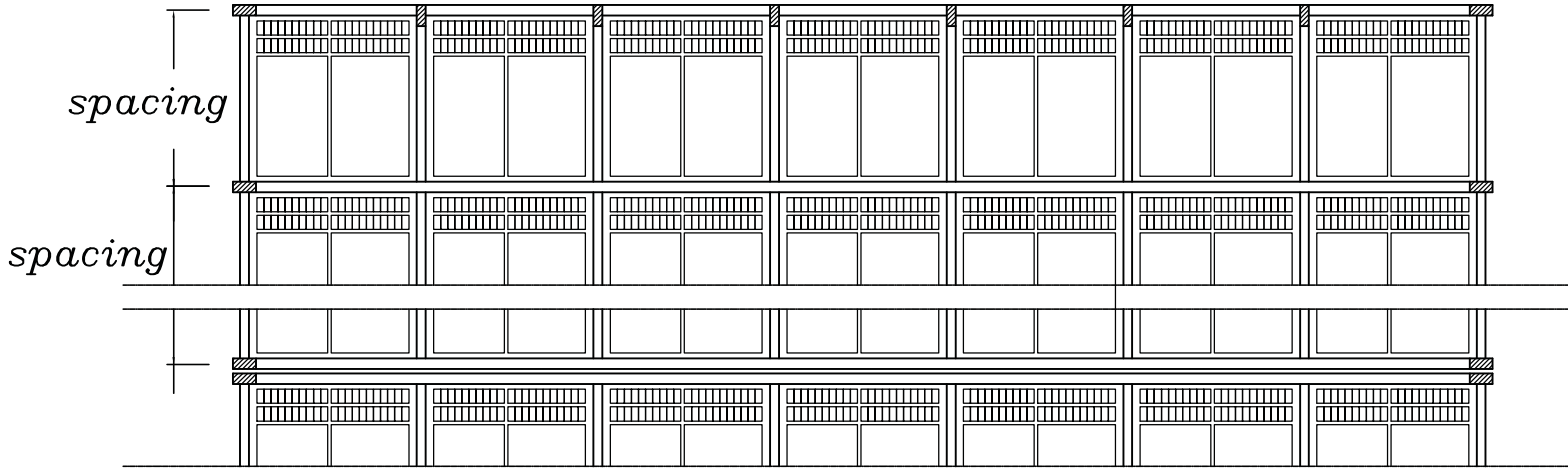


KEY PLAN

1:200 ⟶ 1:400



Elevation

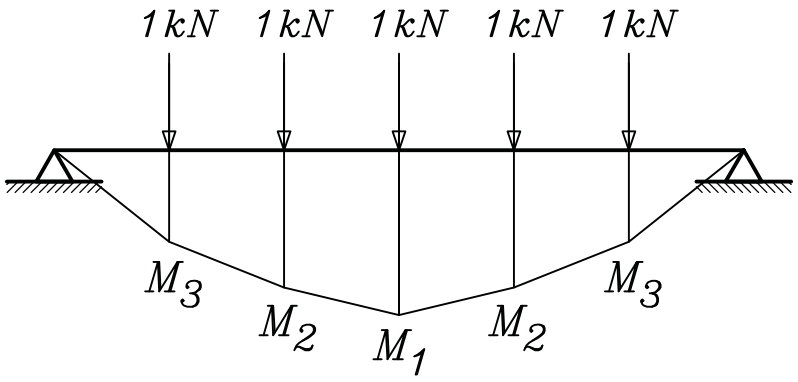


Plan

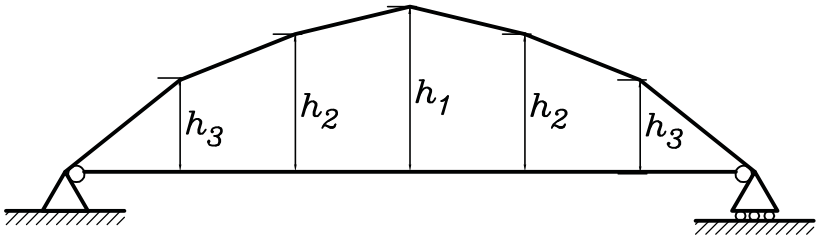
How to draw Arch girder

- نفرض للكمرات الثانوية رد فعل = $1.0kN$

- نرسم شكل $(B.M.D.)$ للـ $(Main\ girder)$



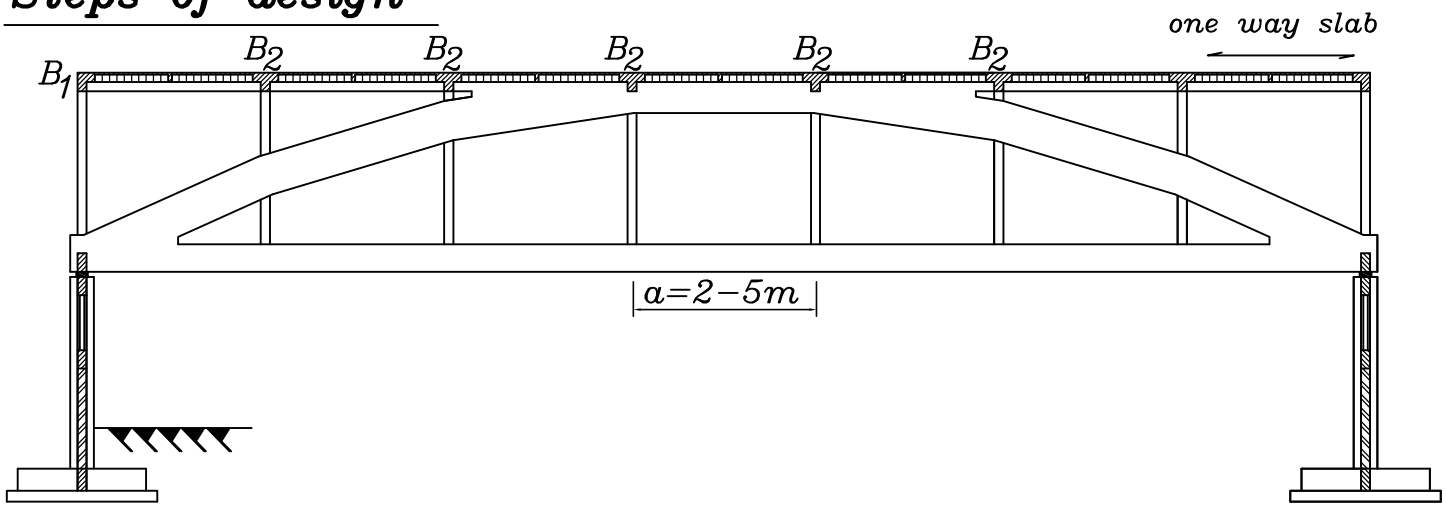
- نتيجة لان شكل $(Arch\ girder)$ هو مقلوب شكل $(B.M.D.)$ بنفس نسب العزوم فانه



$$\frac{h_1}{M_1} = \frac{h_2}{M_2} = \frac{h_3}{M_3}$$

- بمعرفة قيمة $h_1 = \frac{L}{6-8}$ يمكن ايجاد الارتفاعات الاخرى h_2 & h_3

Steps of design



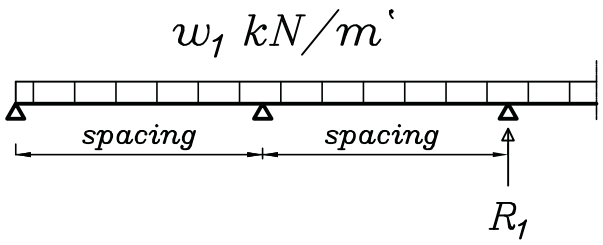
1)Load From Slab:

$$w_{su}=1.4[t_s\gamma_c+F.c.]+1.6L.L \quad (for\ S.S.)$$

$$w_{su}=\frac{1.4[t_s\gamma_c*(e+b)+bh\gamma_c+5*wt.of\ block]}{(e+b)}+1.4F.C.+1.6*L.L. \quad =---kN/m^2$$

For B_1

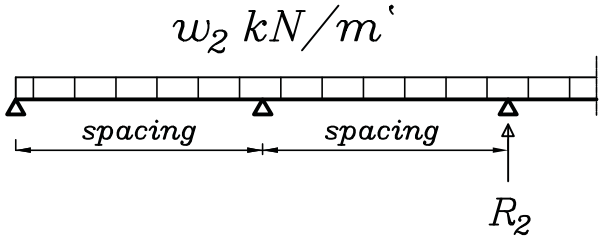
$$w_1=\gamma_c bt*1.40+w_s\ \frac{a}{2}\ kN/m'$$



$$R_1=w_1*Spacing$$

For B_2

$$w_2=\gamma_c bt*1.40+w_s*a \qquad kN/m'$$



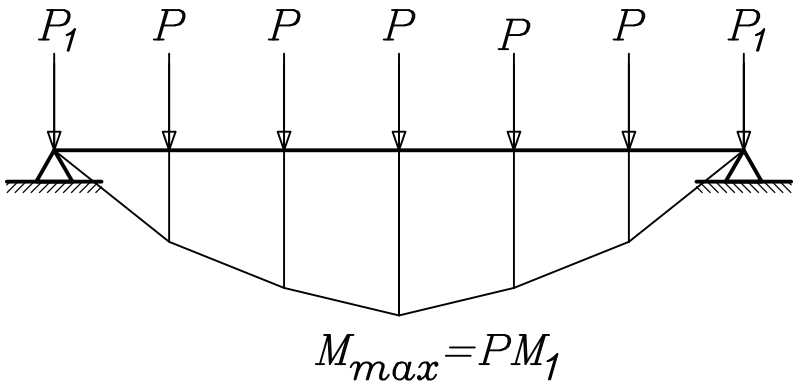
$$R_2=w_2*Spacing$$

2)Design of Arch girder:

$P = R_2 + o.w \ of \ Arch * a$

$P_1 = R_1 + o.w \ of \ Arch \ (\frac{a}{2})$

where $o.w.of \ Arch \ girder = 12 \longrightarrow 14 kN/m'$ (working)



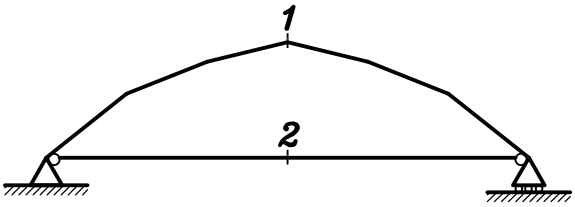
$M_{max} = PM_1$

Get $M_{max} = PM_1$

Where M_1 is B.M. at midspan due to 1.0kN

$$C = T = \frac{0.95 M_{max}}{h} \quad , \quad M_{des} = 0.05 M_{max}$$

Design of sections:



Sec.(1-1) $N_{u.l.} = \frac{0.95 M_{max}}{h}$

$M_{u.l.} = 0.05 M_{max}$

Sec.(2-2) $T_{u.l.} = \frac{0.95 M_{max}}{h} \longrightarrow A_s = \frac{T_{u.l.}}{f_y / \gamma_s}$

3) Design of hanger

$$T = o.w.(hanger) + o.w.(Tie) + R_2$$

$$= 0.25^2 * \gamma_c * 1.40 * h + \gamma_c b t_{tie} * 1.40 * a + R_2$$

$$A_s = \frac{T}{f_y / \gamma_s}$$

ملحوظة

اذا كانت البلاطة علوية فان الـ(hanger) لا يحمل أى كمرة وبالتالى

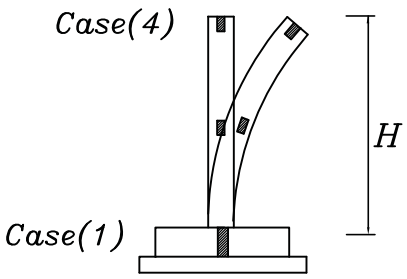
$$T = 0.25^2 * \gamma_c * 1.40 * h + \gamma_c b t_{tie} * 1.40 * a$$

4)Design of Columns

$$N_{u.l.} = \Sigma P / 2$$

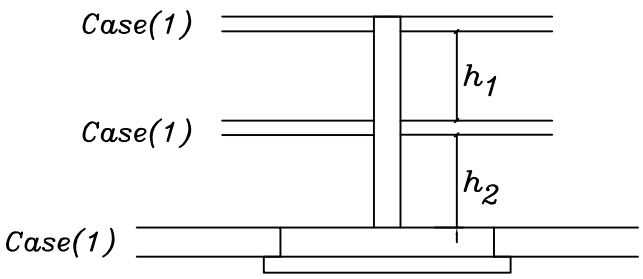
Check Buckling

Inside plane



$$\lambda_{b_{in}} = \frac{2.2 * H}{t}$$

Outside plane

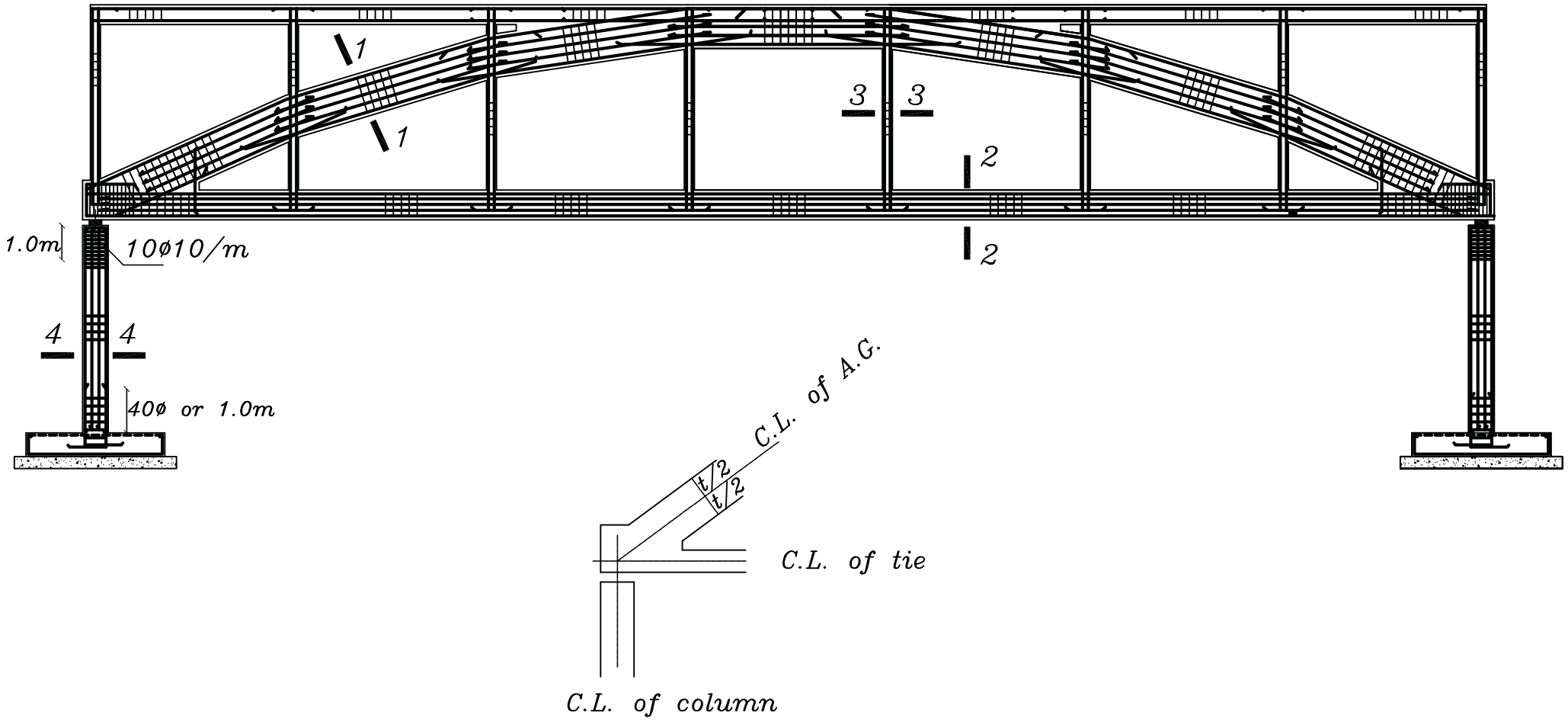


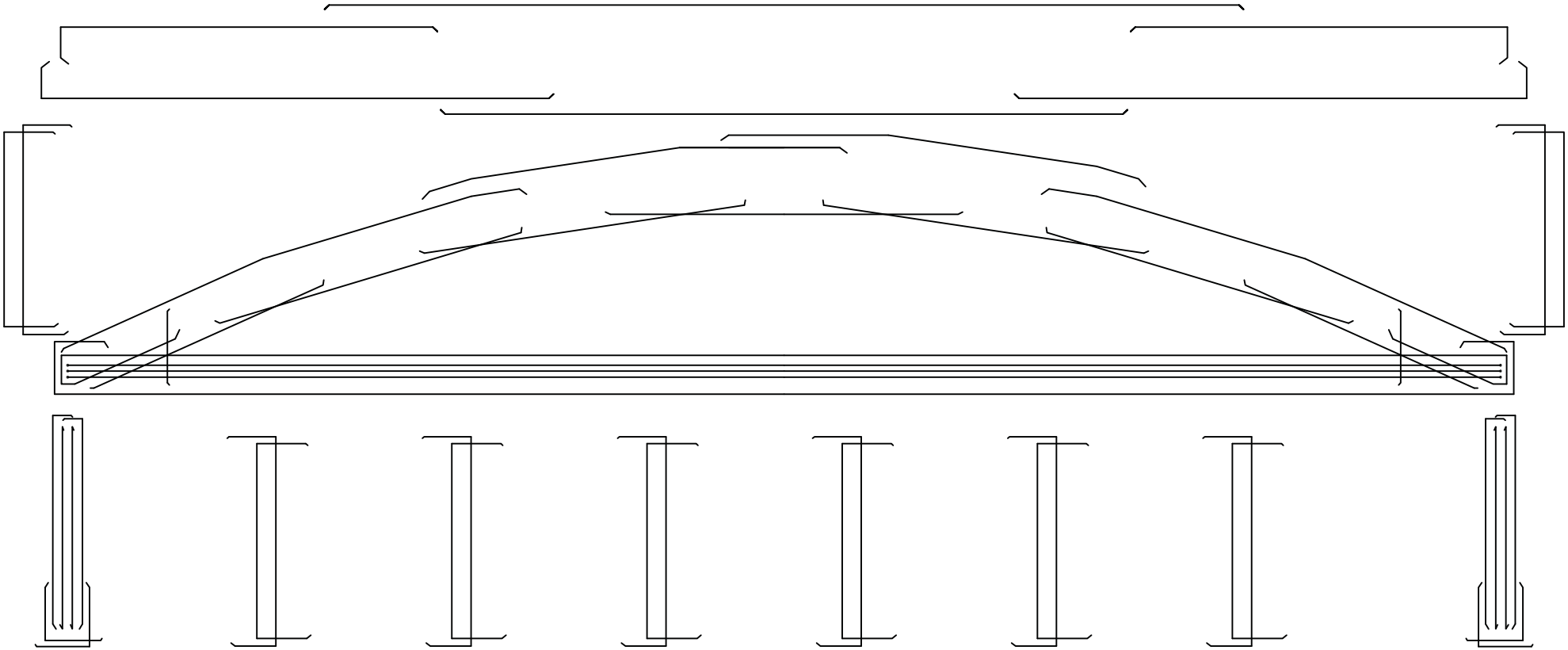
$$\lambda_{b_{out}} = \frac{1.2 * h_{max}}{b}$$

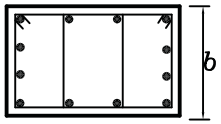
(Where h_{max} is the bigger from h_1 , h_2)

Design section on $N_{u.l.}$, M_{add}

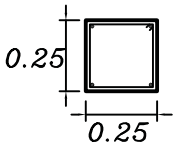
R.F.T. of the Arch girder



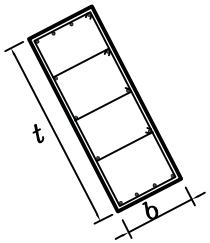




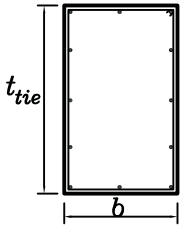
Sec.4−4



Sec.3−3



Sec.1−1

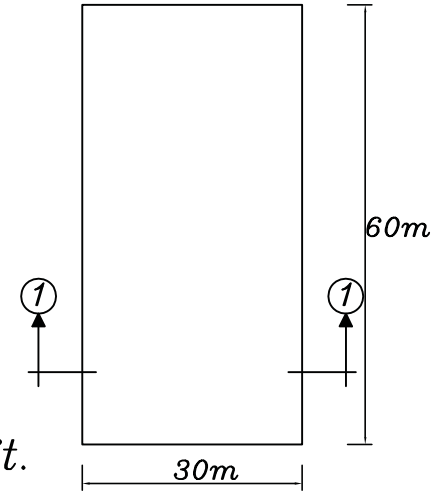


Sec.2−2

Example

For the given plan and cross-section,

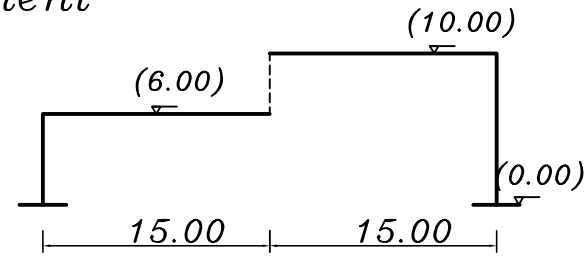
it is required to:



1-Choose the suitable system to cover this Area.

2-Design all Slabs and draw plan of Rft.

3-Design the main supporting element and draw details of Rft.



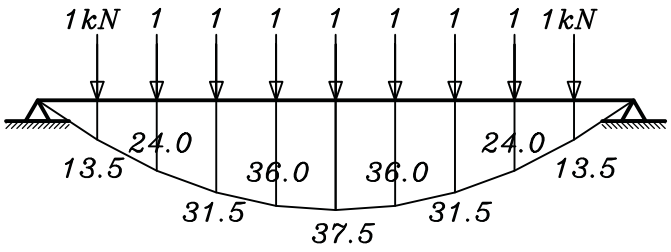
Sec.(1-1)

$F.C.=1.5kN/m^2$, $L.L=1.0\ kN/m^2$

$f_{cu}=25\ N/mm^2$ $f_y=360\ N/mm^2$

Solution

To draw Arch girder:



$h_1=4.00m$

$$\frac{4}{37.5}=\frac{h_2}{36}=\frac{h_3}{31.5}=\frac{h_4}{24}=\frac{h_5}{13.5}$$

$h_2=3.84m$, $h_3=3.36m$, $h_4=2.56m$, $h_5=1.44m$

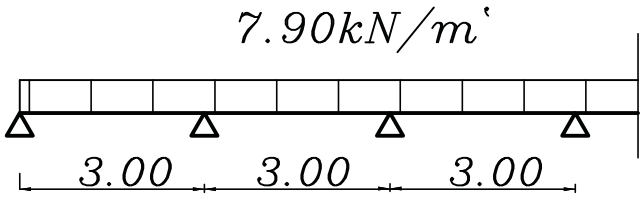
Design of solid slabs

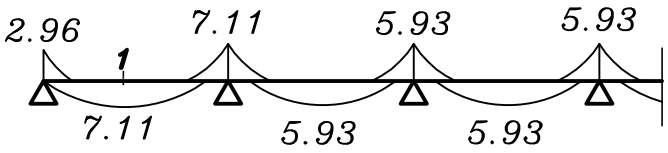
$t_s = \frac{300}{24} = 12.5cm$

take $t_S = 12$ cm (Check def.)

$w_{su} = 1.4[0.12*25+1.5]+1.6*1.0$

$w_{su} = 7.9$ kN/m^2





Sec. (1-1)

$100 = C_1 \sqrt{\frac{7.11*10^6}{1000*25}}$ $C_1 = 5.93$ $J = 0.826$

$A_S = \frac{7.11*10^6}{0.826*100*360} = 2.39cm^2/m` = 5\phi 8/m`$

For Secandry beams (250*500)

For B_1

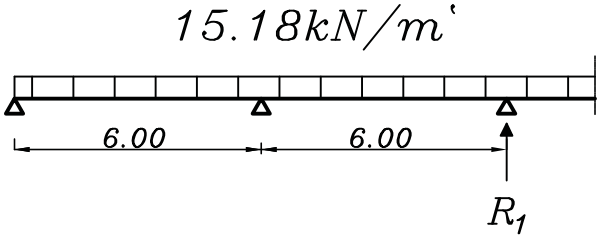
$w_1 = \gamma_c b(t-t_s)*1.40+w_s\frac{a}{2}$ kN/m`

$w_1 = 25*0.25*(0.5-0.12)*1.40+7.9*\frac{3.0}{2}$

$w_1 = 15.18kN/m`$

$R_1 = w_1 * Spacing$

$R_1 = 15.18*6 = 91.05kN$

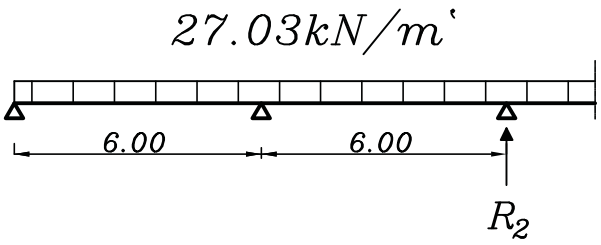


For B_2

$w_2 = \gamma_c b(t - t_s)*1.40 + w_s * a$ kN/m`

$w_2 = 25*0.25*(0.5-0.12)*1.40 + 7.9*3.0$

$w_2 = 27.03 kN/m`$



$R_2 = w_2 * Spacing$

$R_2 = 27.03*6 = 162.15 kN$

Design of Arch girder

$P = R_2 + o.w \ of \ Arch \ girder * a$

$P = 162.15 + 13*1.40*3$

$P = 216.75 kN$

$P_1 = R_1 + o.w \ of \ Arch \ (\frac{a}{2})$

$P_1 = 91.05 + 13*1.40*1.50 = 118.35 kN$

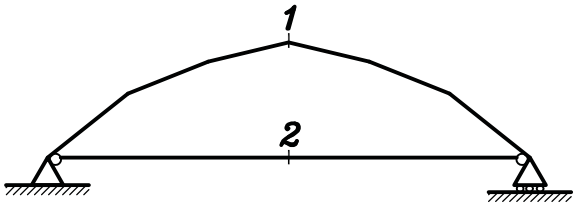
$M_{max} = PM_1 = 216.75*37.5$

$M_{max} = 8128.13 \ kN.m$

$C = T = \frac{0.95 M_{max}}{h} = \frac{0.95*8128.13}{4} = 1930.43 \ kN$

$M_{des} = 0.05 M_{max} \rightarrow M_{des} = 0.05*8128.13$

$M_{des} = 406.4 \ kN.m$



Sec. (1-1) (300*1000)

$N_u = 1930.43 kN$ $M_{u.l} = 406.4 \ kN.m$

$\frac{N_{u.l}}{b t f_{cu}} = \frac{1930.43*10^3}{300*1000*25} = 0.26$

$$e=\frac{M_{u.l}}{N_{u.l}}=\frac{406.4}{1930.43}=0.21 \quad \rightarrow \quad \frac{e}{t}=\frac{0.21}{1}=0.21<0.5$$

use I.D.

$$\frac{Mu.l}{bt^2 f_{cu}}=\frac{406.4*10^6}{300*1000^2*25}=0.05$$

$\rho<1$ Take $\rho=1$

$$A_s=A_s'=1*10^{-4}*25*300*1000$$

$$A_s=A_s'=750mm^2=7.50cm^2$$

$$A_{S\ Total}=7.50*2=15.0\ cm^2$$

$$A_{S\ min}=\frac{0.6}{100}*30*100=18.0cm^2$$

$$A_s=12\phi 16$$

Sec. (2-2) (300*600)

$$T_{u.l}=1930.43\ kN$$

$$As=\frac{Tu.l}{f_y/\gamma_s}\quad\frac{1930.43*10^3}{360/1.15}$$

$$As=61.7cm^2 \quad =14\phi 25$$

Desin of hanger

$$T_{u.l}=0.25^2*4*25*1.40+0.3*0.6*25*1.40*3+162.15$$

$$T_{u.l}=189.80\ kN$$

$$As=\frac{189.80*10^3}{360/1.15}=6.06cm^2=4\phi 16$$

Design of Columns (300*750)

$N_{u.l.} = \Sigma P/2$

$N_{ul.} = \frac{9*216.75}{2} + 118.35$

$N_{ul.} = 1093.73 \ kN$

$\lambda_{b_{in}} = \frac{2.2*6.75}{0.75} = 19.8 \checkmark$ $\lambda_{b_{out}} = \frac{1.2*4.25}{0.30} = 17.00$

Buckling inside plane

$\delta_b = \frac{\lambda_b^2 \ t}{2000} = \frac{19.80^2*0.75}{2000} = 0.147m$

$M_{add} = 1093.73*0.147 = 160.78kN.m$

$\frac{N_{u.l.}}{btf_{cu}} = \frac{1093.73*10^3}{300*750*25} = 0.19$ $\zeta = \frac{750-100}{750} = 0.87$

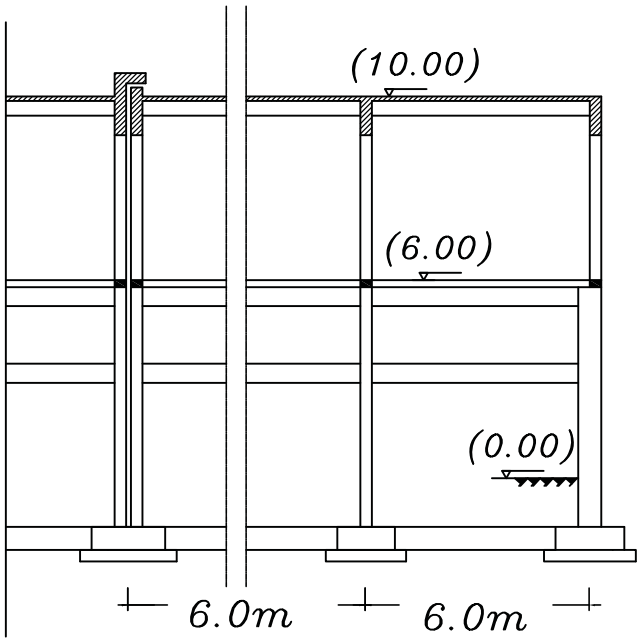
$\frac{M_{u.l.}}{bt^2 f_{cu}} = \frac{160.78*10^6}{300*750^2 \ *25} = 0.038$

$\rho < 1$ Take $\rho = 1$

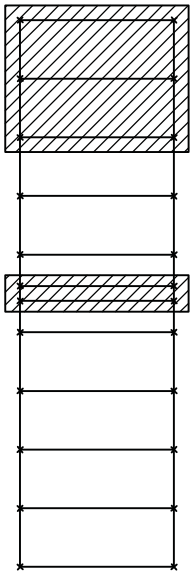
$A_s = A_s' = 1*10^{-4}*25*30*75 = 5.63cm^2$

$A_{S \ min} = \frac{0.25+0.052*19.80}{100} *30*75 = 28.79cm^2$

$A_s = 12 \phi 18$

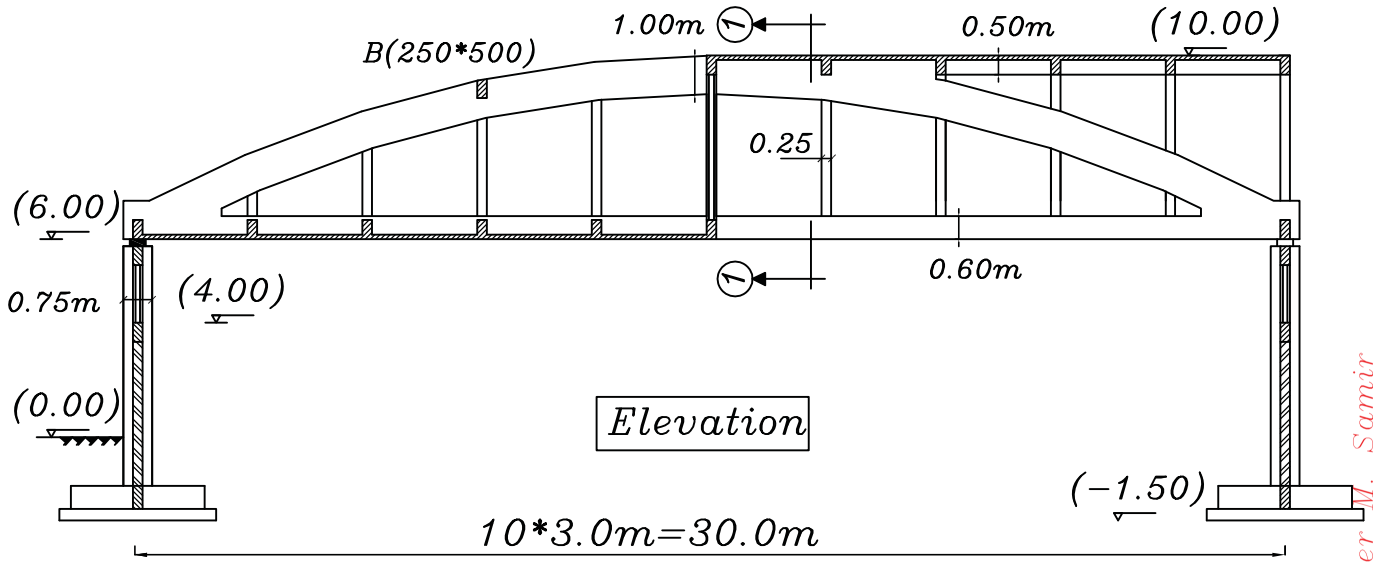


Side view

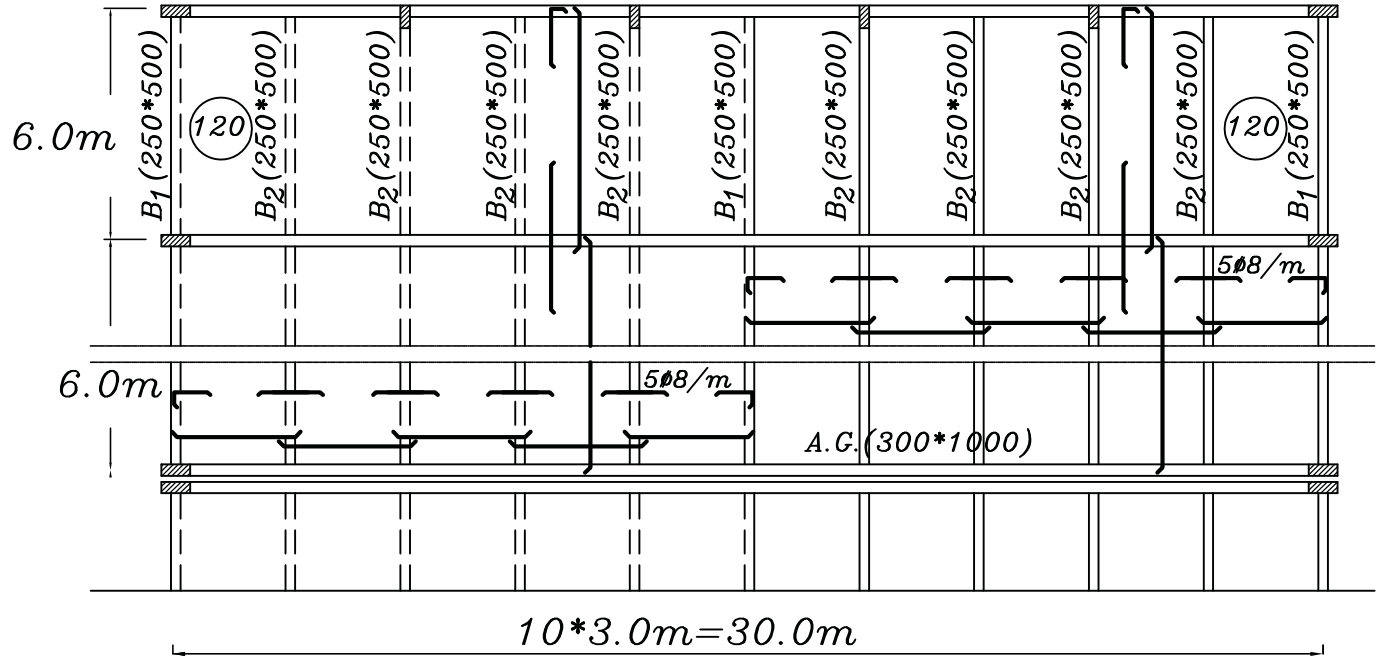


KEY PLAN

1:200 ⟶ 1:400

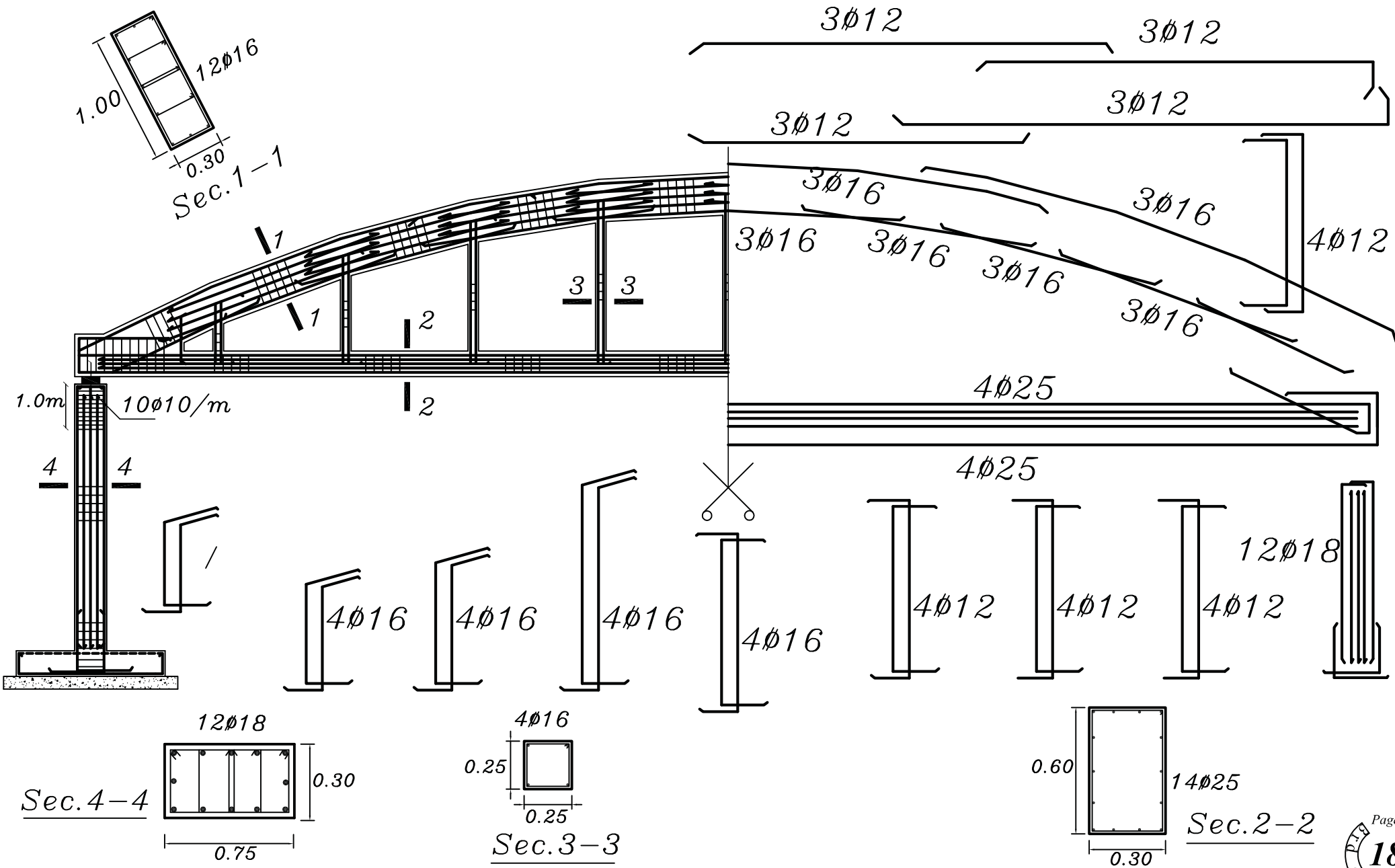


Elevation

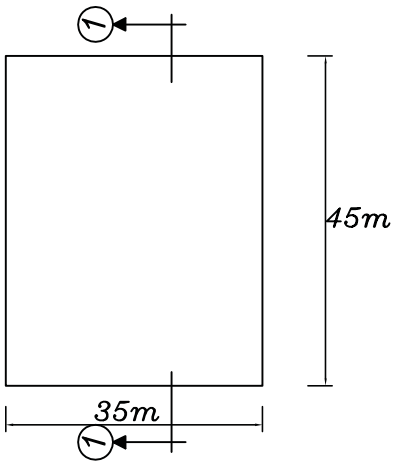


Plan

R.F.T. of the Arch girder



Example



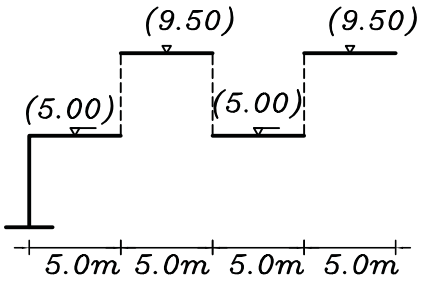
For the given plan and cross-section,

it is required to:

1-Choose the suitable system to cover this Area.

2-Design all Slabs and draw plan of Rft.

3-Design the main supporting element and draw details of Rft.



Sec.(1-1)

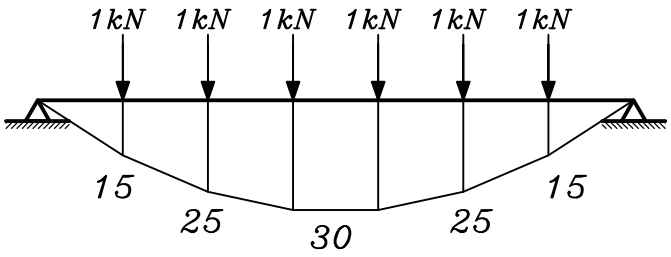
$F.C.=1.5kN/m^2$, $L.L=1.0\ kN/m^2$

$f_{cu}=25\ N/mm^2$ $f_y=360\ N/mm^2$

wt block $=0.15\ kN$

Solution

To draw Arch girder:



$h_1=4.50m$

$$\frac{4.5}{30.0}=\frac{h_2}{25.0}=\frac{h_3}{15.0}$$

$h_2=3.75m$, $h_3=2.25m$

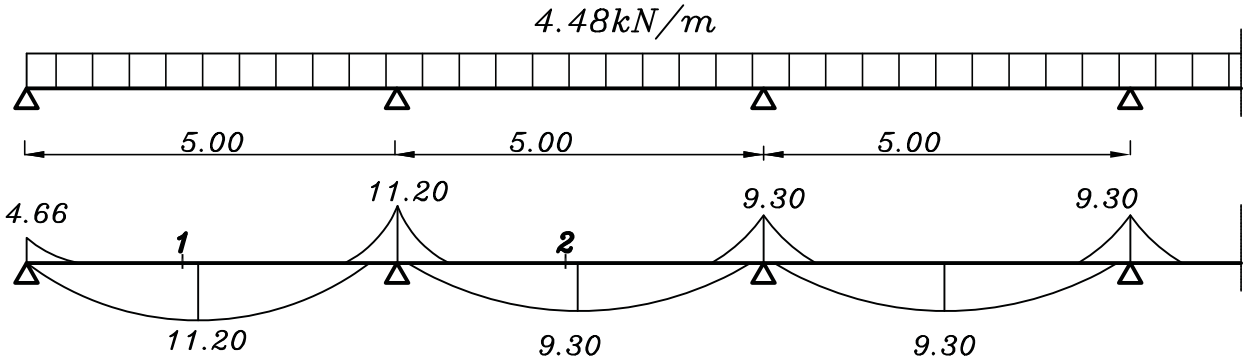
Design of H.B.slabs

$t_s = \frac{500}{18} = 27.78cm$ Take $t = 25cm$ [20cm+5cm] (block) (slab)

$$w_{su} = \frac{1.4[0.05*25*0.5+0.1*0.2*25+5*0.16]}{0.50} + 1.4*1.5+1.6*1.0$$

$w_{su}=8.95 \ kN/m^2$

$w_{su/Rib}=0.5*8.95=4.48kN/m'$



Sec. (1-1)

$220=C_1\sqrt{\frac{11.20*10^6}{500*25}}$ $C_1=7.52$ $J=0.826$

$A_s = \frac{11.20*10^6}{0.826*360*220} = 171mm^2/rib$

$A_s = 2\phi 12/rib$

Sec. (2-2)

$A_s = \frac{9.30*10^6}{0.826*360*220} = 142mm^2/rib$

$A_s = 2\phi 10/Rib$

For Secandry beams (250*500)

For B_1

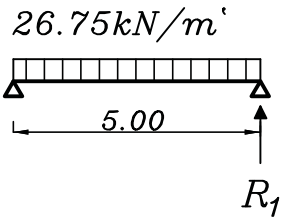
$$w_1 = \gamma_c bt*1.40 + w_s \frac{a}{2} \quad kN/m'$$

$$w_1 = 25*0.25*0.5*1.40 + 8.95* \frac{5.0}{2}$$

$$w_1 = 26.75 kN/m'$$

$$R_1 = w_1 * Spacing/2$$

$$R_1 = 26.75*5/2 = 66.88 kN$$



For B_2

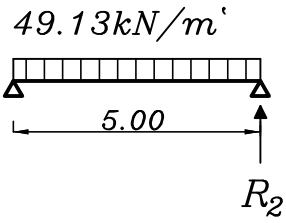
$$w_2 = \gamma_c bt*1.40 + w_s *a \quad kN/m'$$

$$w_2 = 25*0.25*0.5*1.40 + 8.95*5.0$$

$$w_2 = 49.13 kN/m'$$

$$R_2 = w_2 * Spacing/2$$

$$R_2 = 49.13*5/2 = 122.80 kN$$



Design of Arch girder

$$P = 2R_2 + o.w \ of \ Arch \ girder*a$$

$$P = 2*122.80 + 14*1.40*5$$

$$P = 343.63 kN$$

$$P_1 = 2R_1 + o.w \ of \ Arch \ (\frac{a}{2})$$

$$P_1 = 2*66.88 + 14*1.40*2.50 = 182.76 kN$$

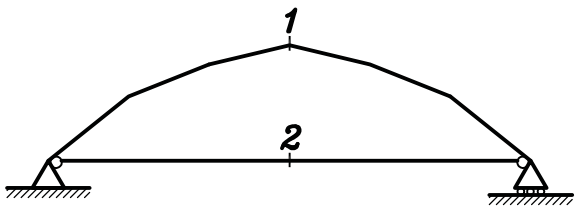
$$M_{max} = PM_1 = 343.63*30.0$$

$$M_{max} = 10308.90 \ kN.m$$

$$C=T=\frac{0.95M_{max}}{h}=\frac{0.95*10308.90}{4.50}=2176.32\ \ kN$$

$$M_{des}=0.05M_{max}\ \rightarrow\ M_{des}=0.05*10308.90$$

$$M_{des}=515.44\ \ kN.m$$



Sec. (1-1) (300*1100)

$N_u=2176.32kN$ $M_{u.l}=515.44\ \ kN.m$

$$\frac{N_{u.l}}{bt\,f_{cu}}=\frac{2176.32*10^3}{300*1100*25}=0.26$$

$$e=\frac{M_{u.l}}{N_{u.l}}=\frac{515.44}{2176.32}=0.24\ \rightarrow\ \frac{e}{t}=\frac{0.24}{1.1}=0.21<0.5$$

use I.D.

$$\frac{Mu.l}{bt^2 f_{cu}}=\frac{515.44*10^6}{300*1100^2*25}=0.06$$

$\rho<1$ Take $\rho=1$

$$A_s=A'_s=1*10^{-4}*25*300*1100$$

$$A_s=A'_s=825mm^2=8.25cm^2$$

$$A_{S\ Total}=8.25*2=16.5\ \ cm^2$$

$$A_{S\ min}=\frac{0.6}{100}*30*110=19.8cm^2$$

$A_s=12\,\phi\,16$

Sec. (2-2) (300*700)

$T_{u.l}=2176.32\ \ kN$

$$A_S=\frac{Tu.l}{f_y/\gamma_s}\quad\frac{2176.32*10^3}{360/1.15}$$

$A_S = 69.52cm^2 = 16\phi 25$

Desin of hanger

$T_{u.l} = 0.25^2 * 4.5*25*1.40 + 0.3*0.7*25*1.40*5 + 122.80$

$T_{u.l} = 169.40 \ kN$

$A_S = \frac{169.40*10^3}{360/1.15} = 5.40cm^2 = 4\phi 16$

Design of Columns (300*650)

$N_{u.l.} = \Sigma P/2$

$N_{ul.} = \frac{6*343.63}{2} + 182.76$

$N_{ul.} = 1213.65 \ kN$

$\delta_{b_{in}} = \frac{2.2*5.75}{0.65} = 19.46$ $\qquad$ $\delta_{b_{out}} = \frac{1.2*3.25}{0.30} = 13.00$

Column is long col. inside & outside plan

$\delta_b = \frac{\delta_b^2 \ t}{2000} = \frac{19.46^2 * 0.65}{2000} = 0.123m$

$M_{add} = 1213.65*0.123 = 149.37kN.m$

$\frac{N_{u.l.}}{btf_{cu}} = \frac{1213.65*10^3}{300*650*25} = 0.25$ $\qquad$ $\zeta = \frac{650-100}{650} = 0.85$

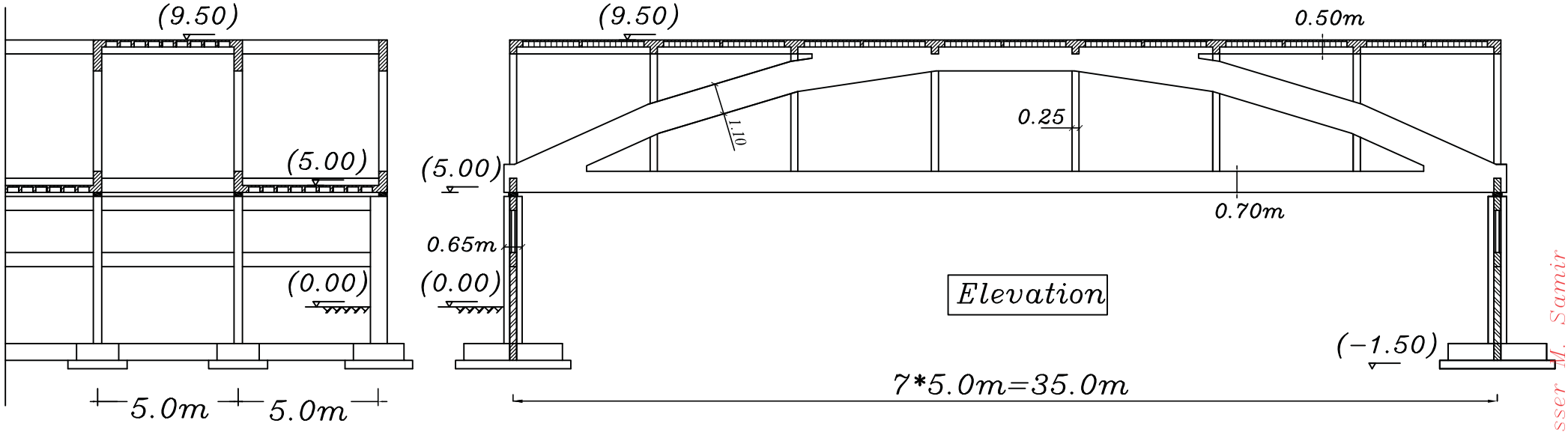
$\frac{M_{u.l.}}{bt^2 f_{cu}} = \frac{149.37*10^6}{300*650^2 * 25} = 0.047$

$\rho < 1$ Take $\rho = 1$

$A_s = A_s' = 1*10^{-4}*25*30*65 = 4.88cm^2$

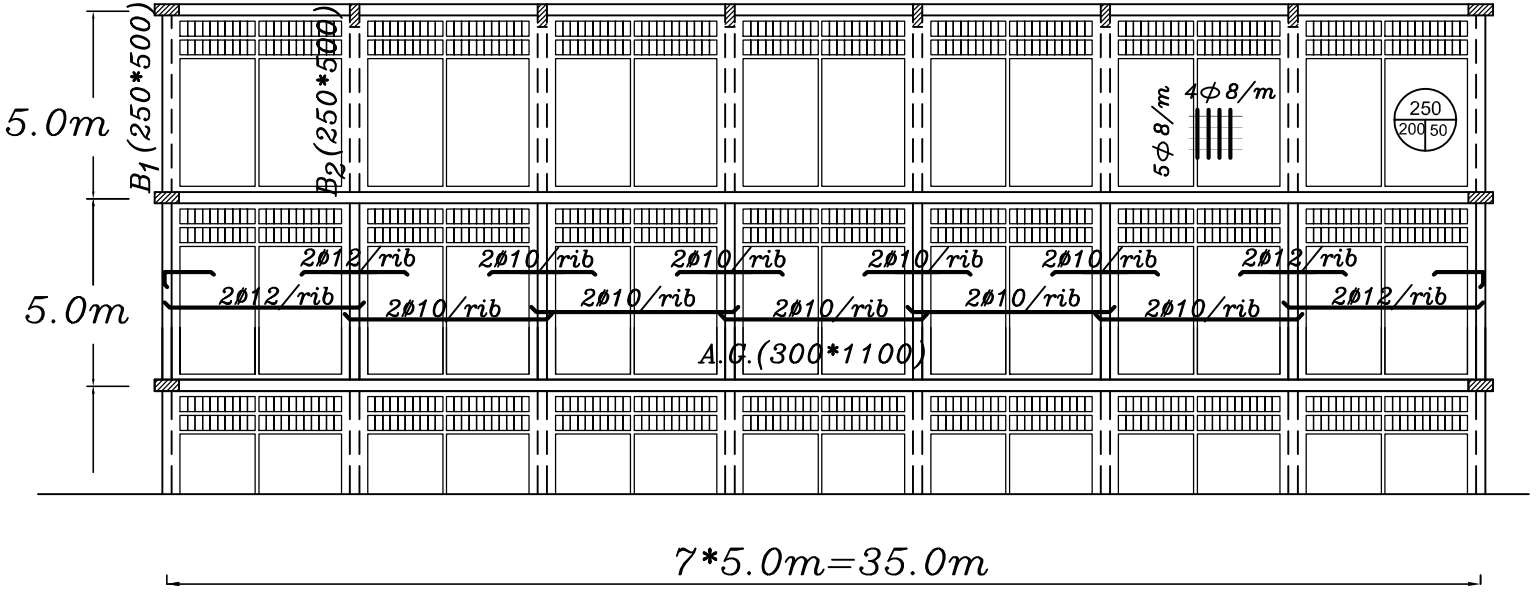
$A_{S\ min} = \frac{0.25+0.052*19.46}{100} * 30*65 = 24.61cm^2$

$A_s = 10\phi 18$



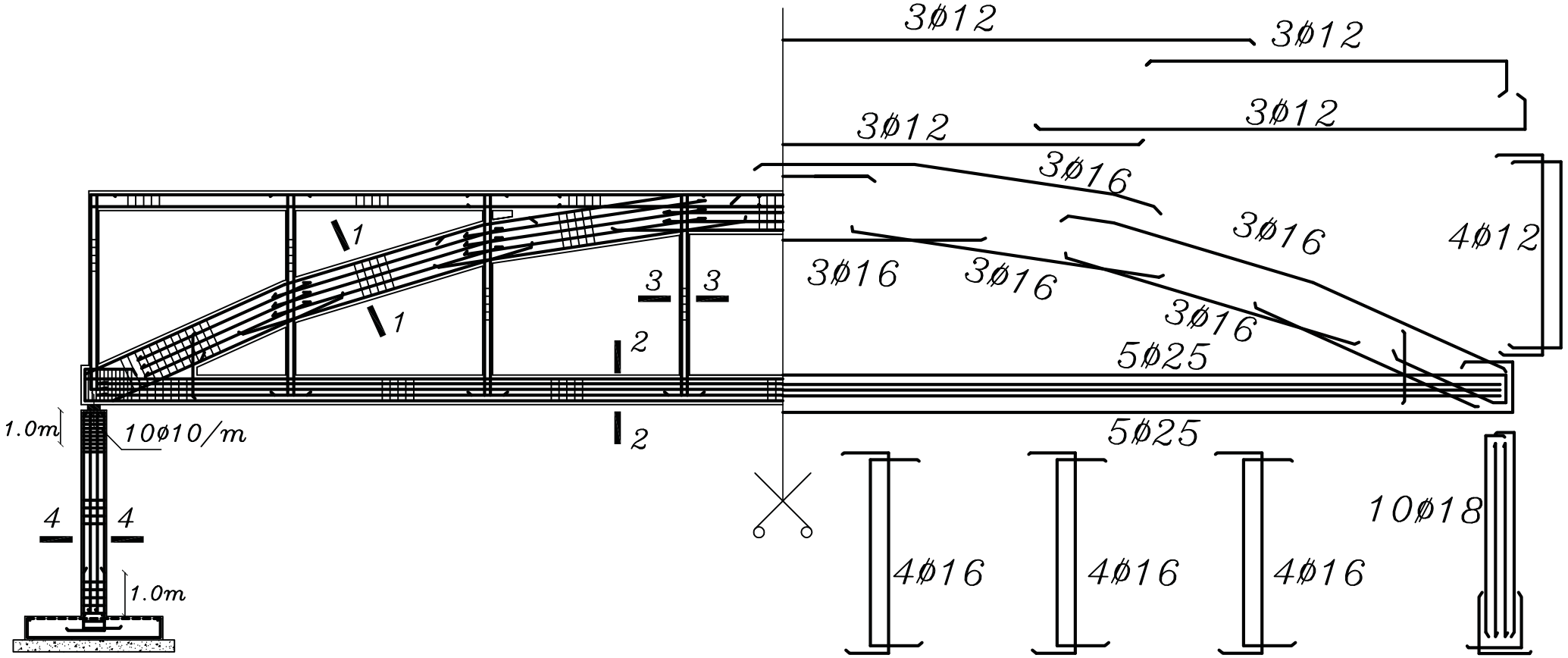
Side view

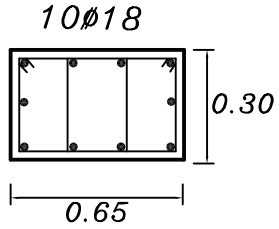
Elevation



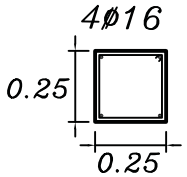
Plan

R.F.T. of the Arch girder

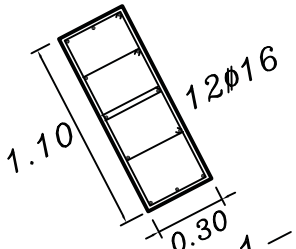




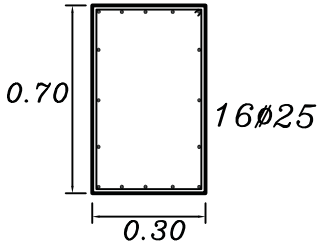
Sec.4−4



Sec.3−3

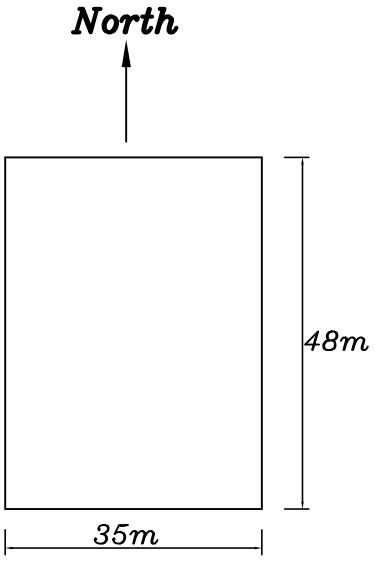


Sec.1−1



Sec.2−2

Example



For the given plan, it is required to:

1- Choose the suitable system to cover this Area.

2- Design all Slabs and draw plan of Rft.

3- Design the main supporting element and draw details of Rft.

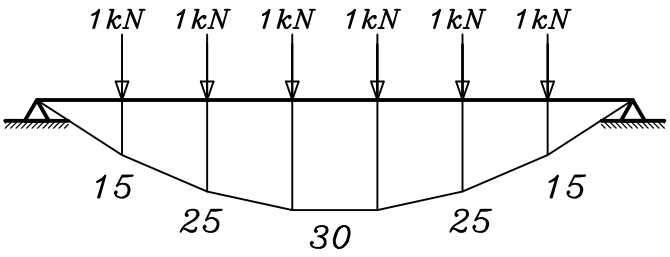
$F.C.=1.5 kN/m^2$, $L.L=0.5\ kN/m^2$

$f_{cu}=25\ N/mm^2$, $f_y=360\ N/mm^2$

wt block $=0.15\ kN$

Solution

To draw Arch girder:



$h_1=4.50m$

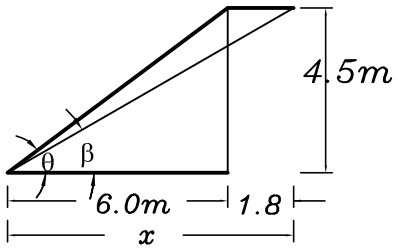
$$\frac{4.5}{30.0}=\frac{h_2}{25.0}=\frac{h_3}{15.0}$$

$h_2=3.75m$, $h_3=2.25m$

Design of H.B.slabs

$$t_s = \frac{500}{18} = 27.78cm$$

Take $t_s = 25cm$ [20cm + 5cm] (block) (slab)



$$\theta = \tan^{-1}\left(\frac{4.5}{6.0}\right) = 36.87 > 30$$

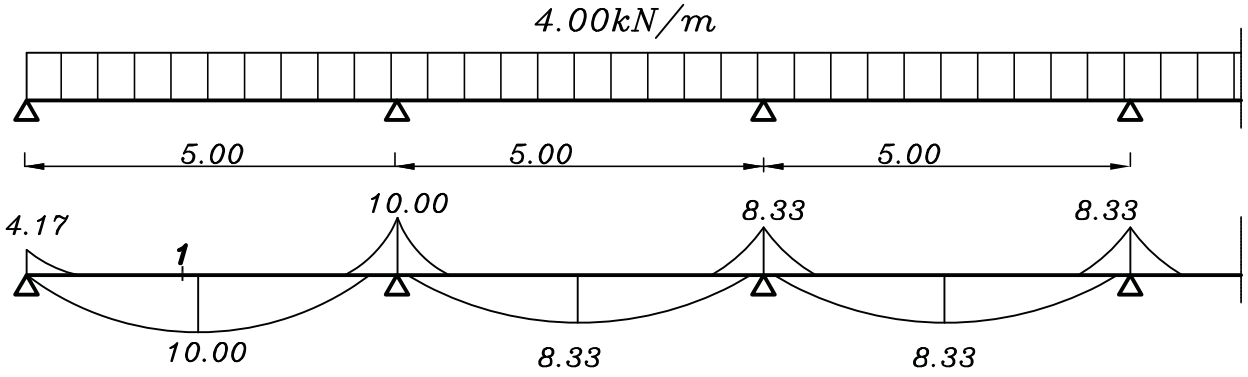
$$\beta = \tan^{-1}\left(\frac{4.5}{x}\right) = 30$$

$$x = 7.80m \longrightarrow L_c = 1.8m$$

$$w_{su} = \frac{1.4[0.05*25*0.5 + 0.1*0.2*25 + 5*0.16]}{0.50} + \frac{1.4*1.5 + 1.6*0.5}{Cos\,\theta}$$

$$w_{su} = 8.00kN/m^2$$

$$w_{su/Rib} = 0.5*8.00 = 4.00kN/m'$$



Sec. (1-1)

$$M_{des.} = M\cos\theta = 10.0*0.8 = 8.0kN.m$$

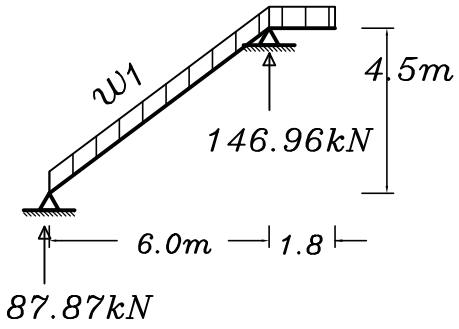
$$225 = C_1\sqrt{\frac{8.00*10^6}{500*25}} \qquad C_1 = 8.89 \qquad J = 0.826$$

$$A_s = \frac{8.00*10^6}{0.826*360*225} = 1.20cm^2/rib$$

$$A_s = 2\,\Phi\,10/rib$$

For Secandry beams (250*600)

For B_1

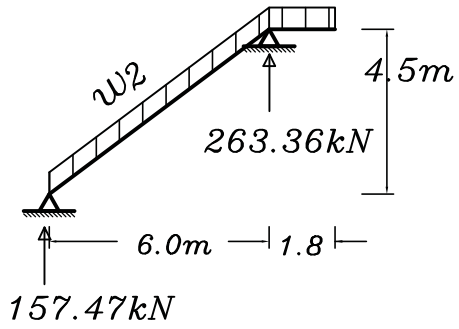


$$w_1 = \gamma_c bt*1.40 + w_s \frac{a}{2} \quad kN/m'$$

$$w_1 = 25*0.25*0.6*1.40 + 8.00* \frac{5.0}{2}$$

$$w_1 = 25.25 kN/m'$$

For B_2



$$w_2 = \gamma_c bt*1.40 + w_s *a \quad kN/m'$$

$$w_2 = 25*0.25*0.6*1.40 + 8.00*5.0$$

$$w_2 = 45.25 kN/m'$$

Design of Arch girder

$$P = 263.36 + 157.47 + o.w \text{ of Arch girder} * a$$

$$P = 263.36 + 157.47 + 14*1.40*5$$

$$P = 518.83 kN$$

$$P_1 = 146.96 + 87.87 + o.w \text{ of Arch } (\frac{a}{2})$$

$$P_1 = 146.96 + 87.87 + 14*1.40*2.50 = 283.83 kN$$

$$M_{max} = PM_1 = 518.83*30.0$$

$$M_{max} = 15564.90 kN.m$$

$$C = T = \frac{0.95 M_{max}}{h} = \frac{0.95*15564.90}{4.50} = 3285.92 \quad kN$$

$$M_{des} = 0.05 M_{max} \rightarrow M_{des} = 0.05*15564.90 = 778.25 kN.m$$

Sec. (1-1) (350*1100)

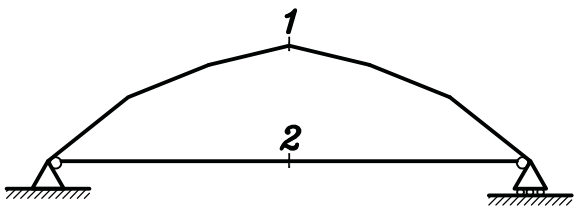
$N_{u.l.} = 3285.92kN$ $M_{u.l} = 778.25kN.m$

$$\frac{N_{u.l}}{bt\,f_{cu}} = \frac{3285.92*10^3}{350*1100*25} = 0.34$$

$$e = \frac{M_{u.l}}{N_{u.l}} = \frac{778.25}{3285.92} = 0.24 \rightarrow \frac{e}{t} = \frac{0.24}{1.1} = 0.21 < 0.5$$

use I.D.

$$\frac{Mu.l}{bt^2 f_{cu}} = \frac{778.25*10^6}{350*1100^2*25} = 0.074$$



$\rho = 2.5$

$A_s = A'_s = 2.5*10^{-4}*25*350*1100$

$A_s = A'_s = 2406.25mm^2 = 24.06cm^2 = 7\phi 22$

$A_{S\ Total} = 24.06*2 = 48.12\ cm^2$

$A_{S\ min} = \frac{0.6}{100}*35*110 = 23.1cm^2 < A_{S\ Total}$ (ok)

Sec. (2-2) (350*700)

$T_{u.l} = 3285.92$ kN

$$A_S = \frac{Tu.l}{f_y/\gamma_s} \quad \frac{3285.92*10^3}{360/1.15}$$

$A_S = 104.97cm^2 = 22\phi 25$

Desin of hanger

$T_{u.l} = 0.25^2*4.5*25*1.40 + 0.35*0.7*25*1.40*5 + 157.74$

$T_{u.l} = 210.46$ kN

$$A_S = \frac{210.46*10^3}{360/1.15} = 6.72cm^2 = 4\phi 16$$

Design of Columns (350*650)

$N_{u.l.} = \Sigma P/2$

$N_{ul.} = \frac{6*518.83}{2} + 283.83$

$N_{ul.} = 1840.32 \ kN$

$\lambda_{b_{in}} = \frac{2.2*5.75}{0.65} = 19.46$ $\qquad$ $\lambda_{b_{out}} = \frac{1.2*3.25}{0.35} = 11.14$

Column is long col. inside & outside plan

$\delta_b = \frac{\lambda_b^2 \ t}{2000} = \frac{19.46^2*0.65}{2000} = 0.123m$

$M_{add} = 1840.32*0.123 = 226.36 kN.m$

$\frac{N_{u.l.}}{btf_{cu}} = \frac{1840.32*10^3}{350*650*25} = 0.32$ $\qquad$ $\zeta = \frac{650-100}{650} = 0.85$

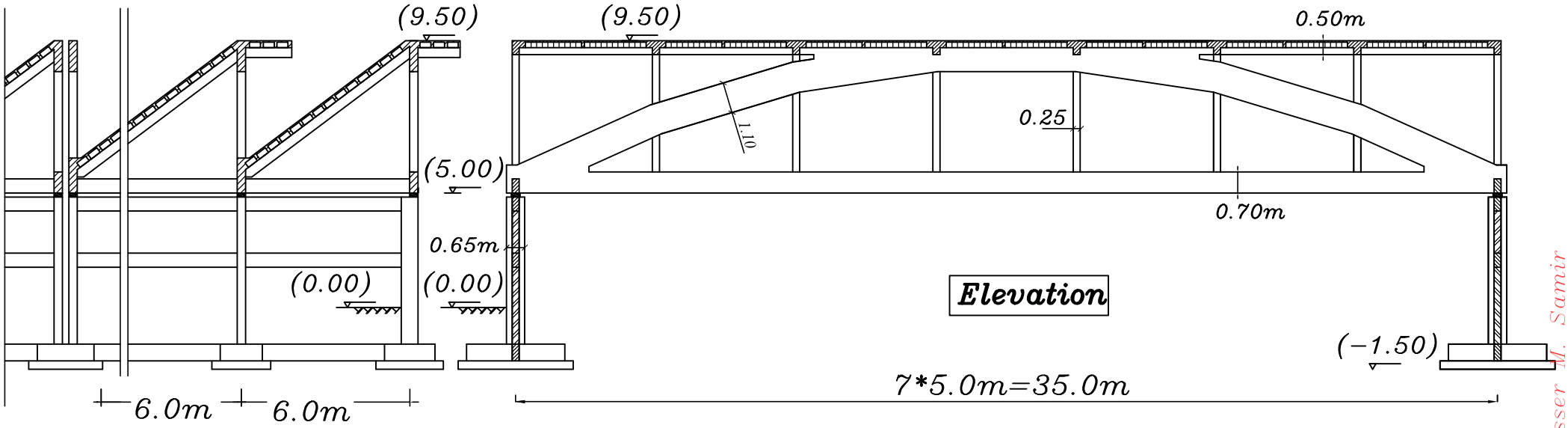
$\frac{M_{u.l.}}{bt^2 f_{cu}} = \frac{226.36*10^6}{350*650^2 \ *25} = 0.061$

$\rho = 1.5$

$A_s = A_s' = 1.5*10^{-4}*25*35*65 = 8.53cm^2$

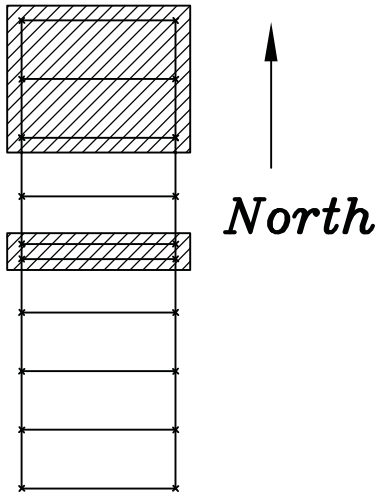
$A_{S \ min} = \frac{0.25+0.052*19.46}{100} *35*65 = 28.71cm^2$

$A_s = 12 \phi 18$



Elevation

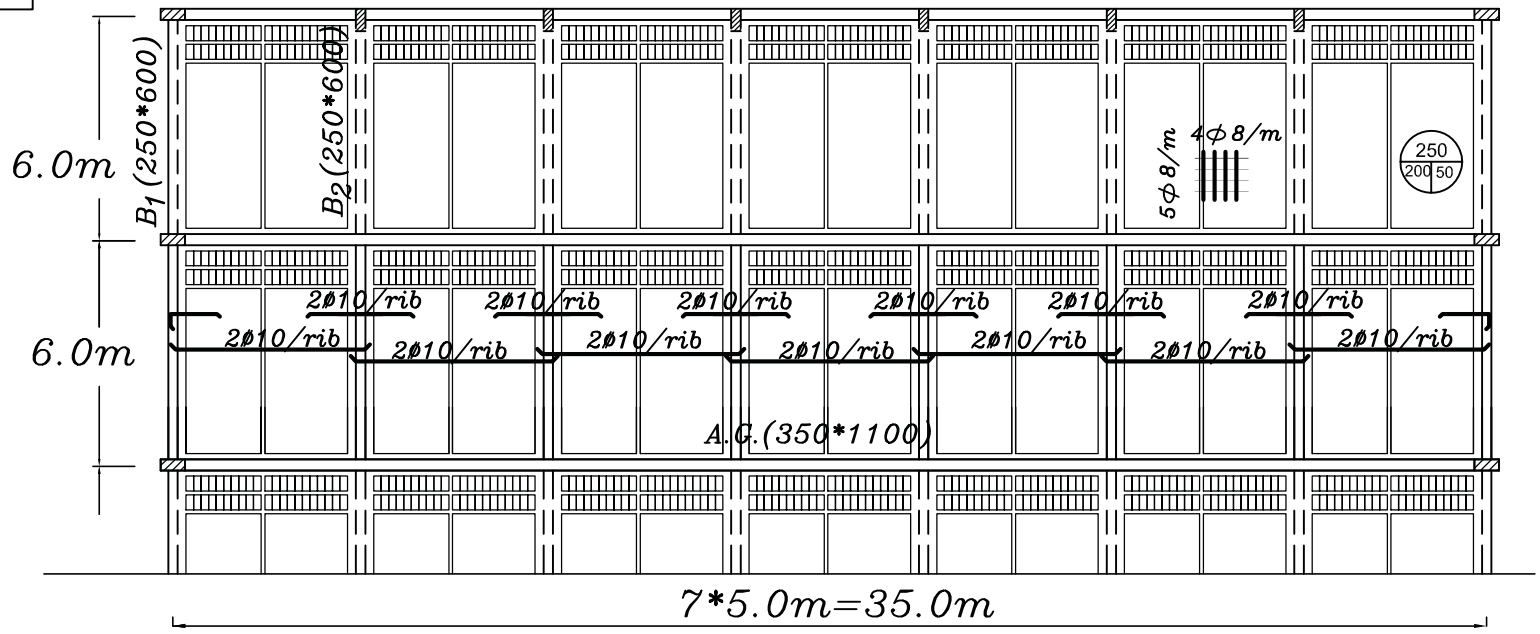
Side view



North

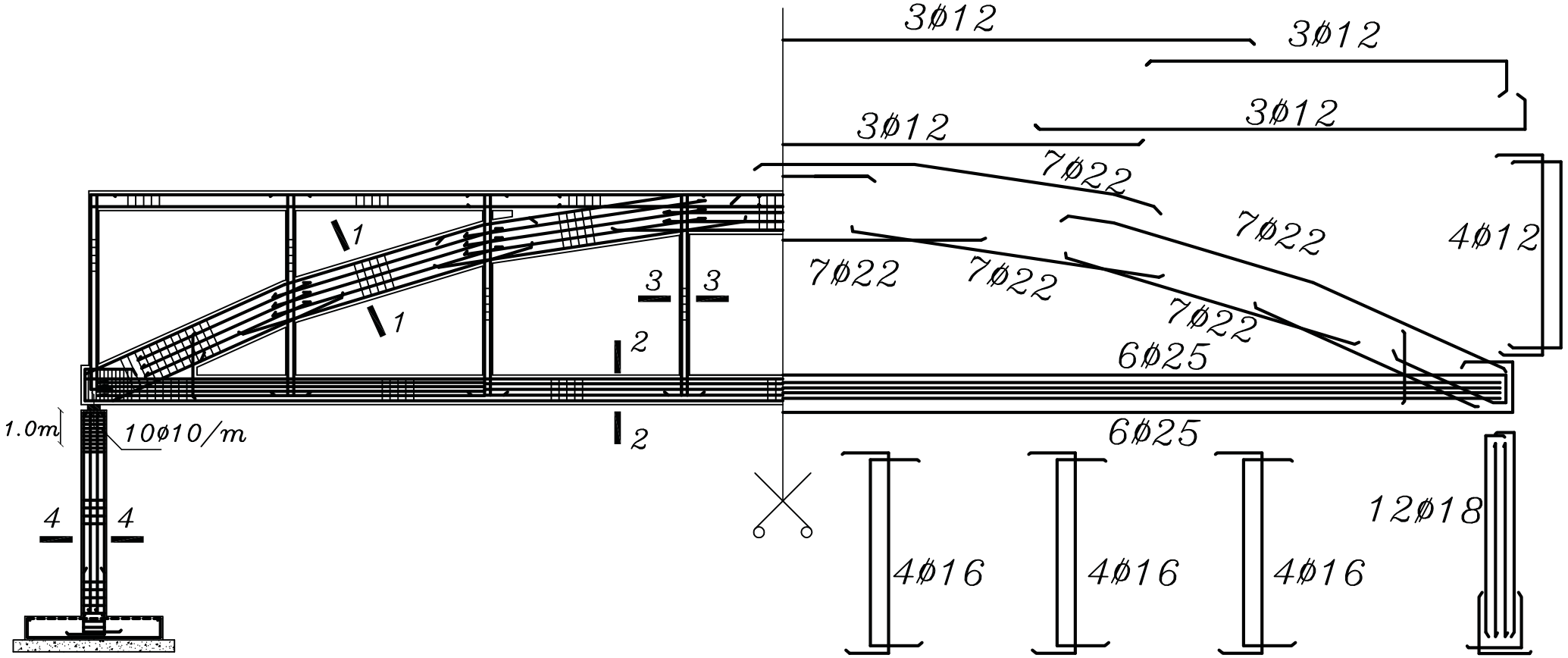
KEY PLAN

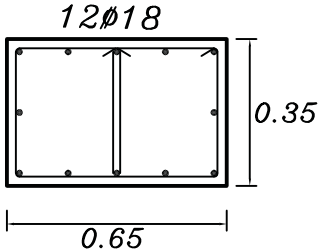
1:200 ⟶ 1:400



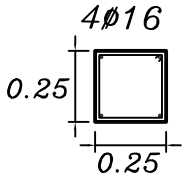
Plan

R.F.T. of the Arch girder

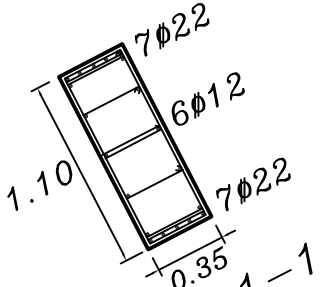




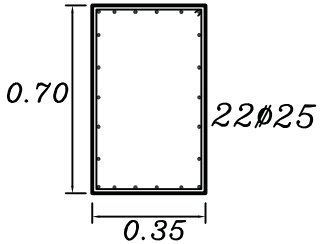
Sec.4−4



Sec.3−3



Sec.1−1



Sec.2−2